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October 9, 2014

Garrett Chun, Project Manager
National Park Service
5083 Foresta Road
El Portal, California 95318

Subject: Summary and Recommendations – El Portal Fire Sediment/Debris Runoff Mitigation, Title I Services Scoping Trip, Old El Portal, California, Yosemite National Park
Condor Project No. 6945

Dear Mr. Chun:

At your request, I performed a site visit to two (2) residential homes located at 5674 Foresta Road, and 9722 Buckeye Road in Old El Portal, California on Monday, August 25, 2014. The site visit, and this letter report, is performed in accordance with our Work Order dated August 22, 2014. The letter report summarizes the activities performed during the site visit, and presents our findings and recommendations to complete the Title I Services – Scoping Trip, as presented in your Scope of Work dated August 20, 2014.

SCOPE OF WORK

In accordance with the above paragraph, the work tasks included the following:

- **Scope Validation.** This was performed by email and phone communication prior to the site visit.
- **Visit and Examine the Site.** This was performed on August 25th, 2014 with Mr. Garrett Chun and other NPS representatives.
- **Review Existing Documentation.** The documents provided for review include the Hydrology Resource Report (HRR) dated August 12, 2014, and 2014 El Portal Fire Geologic Hazard Assessment Report, dated August 2104 (GHAR). The pertinent sections of each of these documents have been reviewed and various sections will be referred to within this letter report. For convenience, a copy of each report is attached to this document.
- **Prepare a Trip Report.** This letter report is intended to meet the requirements of the trip report.

SITE VISIT

During my site visit, the two following sites were viewed by visual inspection by foot:

- **9722 Buckeye Road:** This site was visited first, and its general location is shown in the HRR in Figure 1 as the southwesterly house of the two houses depicted and shown at the base of the Buckeye Drainage. Site Photos 2193 through 2204 were taken near the base of the drainage and backyard of the existing house. Photo 2222 was taken at the location indicated as

"Rock Armored Dip" in Figure 4 (HRR), "Location and types of proposed treatments". The photos are provided in an attached folder without edits or text for base photos. Selected photos will be provided within this letter report.

- **5674 Foresta Road:** This site was visited second, and its general location is shown in the HHR, Figure 1, as the more northeasterly house and shown at the base of the Water Tank Drainage. Site Photos 2205 through 2208 were taken near the house (2205 taken of the tank across Foresta Road), and Photos 2209 through 2221 were taken near the existing rock gabion debris dam referred to in the HRR (pg. 2, House in drainage near water tank).

EXISTING DOCUMENTATION

Two-Year Storm Event

The Hydrology Resource Report (HRR) provides a detailed hydrology and sediment yield assessment of the two subject areas as well as other areas affected by the 4,729 acre El Portal fire. Mean annual precipitation is stated as 39 inches, and more specifically, 38.1 inches at the two subject sites.

The HRR predicted the pre-fire and post fire total sediment volumes for a 2-year storm. A 2-year storm has a 50% probability of occurring in any given year, and a 94 % probability of occurring once over the next 4 consecutive years (pg. 5). The sediment volume calculations yielded the following results:

Sediment Yields for 2-Year Event

Watershed	Pre-Fire Total Volume (Cubic Yards)	Year 1 Post-Fire (Cubic Yards) Erosion Volume
Buckeye Road Drainage (Buckeye)	4	89
Water Tank Drainage (Foresta)	9	203

The HRR states that "Post-fire 2-year flows for the water tank drainage (6 cubic feet per second (cfs)) [Foresta] and the Buckeye Road drainage (3 cfs) may not appear very impressive at first but considering that the houses are located squarely in the drainage and the volume of sediment predicted to be delivered by a 2-year event (203 cu yds to water tank, 89 cu yds to Buckeye), both houses are at risk due to flooding, mud and possibly debris flows (for visualization purposes, 6 cfs can fill a 20,000 gallon swimming pool in 7.5 minutes)." (Quoted pg. 6, Results and Discussion) Additional discussion is also provided regarding historic debris flows in March 1991 and in 2011.

Catastrophic Event

The 2014 El Portal Fire Geologic Hazard Assessment Report (GHAR) studied and summarized the risk of debris flows at various precipitation events, including the 2-, 5-, 10-, 25-, and 50-year storm events. They summarize their analysis by stating the following:

"An emergency exists at the two houses in El Portal. There is a threat to life and property from debris flows that have a Moderate Debris Flow Hazard, 20-40% probability of occurring, with a potential for debris flow volumes from 1,000 – 10,000 yds^3. House #1 is located at 5674 Foresta Road and House #2 is located at 9722 Buckeye Road."

For comparison, a standard 10-wheel dump truck can safely hold 8 to 10 yards. Therefore, the event that they refer to would generate enough debris to fill 100 to 1,000 dump trucks. Due to the nature of debris flows, this volume of material could come upon a structure within seconds to 10's of seconds without warning. Because of the high risk to life safety without warning, we are referring to this as the "Catastrophic Event".

Summary of Existing Documentation

Combining the above summaries and restating, we would summarize in the following manner:

As far as can be predicted with the standard predictive tools used for such work, it is almost certain (a 2-year precipitation event) that between 100 to 200 yards of sediment will be generated from the upslope areas to each of the two subject sites over the next few years unless intercepted, diverted, or contained. However, managing the most likely event does little to reduce the risk of a catastrophic event with a relatively high probability (the Emergency Determination with a 20% to 40% probability).

RECOMMENDATIONS

During our site visit on August 25th, we observed the conditions of the two subject sites described in detail in the two referenced documents. We did not observe any conditions that would cause us to alter on question the referenced documents, and both documents appear to be thorough. Our recommendations for the 2-year event will be described for each site independently, and the catastrophic event independently.

Foresta Road House 2-year Event

The HRR recommends the following treatments for the Foresta Road house (pg 6):

House in drainage near water tank on Foresta Road

- The existing gabion dam debris basin adjacent to the upper water tank should be initially cleaned out and then subsequently monitored and cleaned out after storms as needed.
- Sand bags or other type of barrier should be used to raise the height of the existing retaining wall/levee to better protect the house from flooding and debris. This structure would be designed in consultation with a geotechnical engineer.

We agree with bullet one (gabion clean-out) since the gabion was designed to retain a volume of 200 cubic yards (CY), and the post fire predicted volume is 203 CY (See Photos 2211 and 2215). We would estimate the cost to perform the removal, monitoring, and subsequent removal over the next 2 to 4 years to range between $10,000 to $50,000, depending on whether additional repairs/stabilization of the gabions are needed at the time of sediment removal, and the number of times removal is needed.

We agree with bullet two (deflection barrier), but recommend a more permanent barrier of the style that owner has started construction on (Photo 2208, attached). The deflection device should be capable of deflecting the post fire flow of 6 cfs, which would allow for the filling of the debris gabion and the subsequent over-top during a 2-year precipitation event or multiple 2-year events in close succession (within a year or multiple years). The height of the deflection barrier could potentially impact the view of the resident due to the close proximity of their window, and the constricting nature of the flow path directly adjacent to the building. If the 6 cfs cannot be reasonably accommodated, the height could be lowered, but should accommodate no less than 2 cfs (the pre-fire peak flow for 2-year event). We would

estimate the cost of engineered design-build improvements to meet the stated criteria to likely range from $20,000 to $50,000 for this item.

Buckeye Road House 2-Year Event

The HRR recommends the following treatments for the Buckeye Road house (pgs. 6 to 7):

House in drainage on Buckeye Road

- A debris basin and/or deflection barrier should be installed at the mouth of the drainage behind the house on Buckeye Road. The structure should be designed to slow the momentum of a debris or mud flow before it reaches the house, have the capacity to provide some storage of fine sediment/larger debris, and redirect flows around the house. The structure could consist of a gabion dam, k-rails, or some other type of temporary or permanent structure. The structure should be designed in consultation with a geotechnical engineer.
- The burned hillslopes in the drainage adjacent to the house should be mulched with weed free straw or wood straw to provide soil ground cover in order to reduce sheet and rill erosion. Straw should be applied at a rate of around 2 tons per acre.

In our opinion, we would suggest an approach similar to that used at the Foresta Road house, whereby a combined gabion or other structure capable of retaining a minimum of 89 CY (post fire, 2-year event), combined with a deflection device immediately adjacent to the house. The retention structure should be located some distance away from the house (See drainage area in Photo 2193, attached) and deflection devise close to the house (see area in vicinity of Photo 2195 and 2196, attached). Both structures should be capable of managing a flow of 3 cfs (post fire 2-year event) for peak flow.

We would estimate the combined cost of these two engineered improvements to range from $50,000 to $200,000.

As to bullet two, these types of efforts to reduce erosion are helpful to reduce 2-year event impacts over time, but do little to reduce the risk of a Catastrophic Event over the next several years.

Catastrophic Event

As stated earlier, managing the most likely event (2-year event) does little to reduce the risk of a catastrophic event (10-year to 50-year precipitation event), and one which has a relatively high probability (20% to 40% probability). It is a bit like asking your 2+ mile per hour car bumper to protect you in a 60 mile per hour accident. The GHAR provides a detailed discussion of a recommended mitigation of the emergency determination in Section IV, Treatment to Mitigate the Emergency. In summary, the mitigation entails an early warning system of potential large storms, and alerting the resident to evacuate. However, in our opinion, the only predictable method to reduce the risk to life or health from a catastrophic event to the level that existed before the fire is the removal of residents from the structures prior to the rainy season.

Because the volumes and flows in a catastrophic event (10-year to 50-year precipitation event) are so high, in both speed of travel of the flood and/or debris, and because the acuteness of the risk rises rapidly over several hours during a large storm, there is not a reasonable engineered improvement that can adequately manage the risk without significant resource impact and cost. We would estimate that physical improvements to manage the risk of a catastrophic event could range from many hundreds of thousands of dollars and above, if improvements could be even be constructed in the given terrain.

Therefore, the recommendations of the early warning system within the GHAR provide a reasonable approach to reducing the life safety risk to a reasonable level, short of removal of the residents. If such a warning system is chosen, it should be rigorous, testable, have suitable backup measures, including in the event of loss of power.

CONCLUSIONS

We recommend physical improvements be made to reduce the impact from the most likely flows and sediment yields, while reducing the risk of a catastrophic event to an acceptable level without physical improvements. The most likely event is the 2-year precipitation event, and improvements include debris structures and deflection structures/drainages for water and sediment flow discussed in the above Recommendations section entitled Foresta Road House 2-Year Event and Buckeye Road House 2-Year event.

Our recommendations for the Catastrophic Event (10-year to 50-year precipitation event) are provided above in the above Recommendations section entitled Catastrophic Event.

We trust this letter provides the information required. If you have any questions, please contact us at (209) 234-0518.

Sincerely,

CONDOR EARTH TECHNOLOGIES, INC.

Ron Skaggs, PE, GE
Vice President, Engineering Services

Attachments:

Hydrology Resource Report, El Portal Fire BAER Assessment, Stanislaus National Forest, (Groveland RD) and Yosemite National Park, August 12, 2014

2014 El Portal Fire Geologic Hazard Assessment Report, Stanislaus National Forest, August 2014

Site Visit Photographs – August 25, 2014

ATTACHMENTS

Hydrology Resource Report

El Portal Fire BAER Assessment

Stanislaus National Forest

(Groveland RD) and Yosemite National Park

August 12, 2014

Zachary Croyle, BAER Team Hydrologist, Stanislaus National Forest

I. Potential Critical Values at Risk (VARs)

A. Human Life and Safety, Property and Infrastructure

- Houses located along the base of hillslopes in the community of old El Portal could be at risk of nuisance erosion and flooding
- Houses located within ephemeral stream drainages in the community of old El Portal could be at risk of more serious flooding and mud or debris flows
- People using forest roads within the burn area (in particular Foresta Road) could be at risk due to rock fall, flooding, and debris flows
- The Highway 140 bridge at Crane Creek could be damaged due to increased post-fire flood flows and cause temporary loss of highway access
- Forest roads could be at risk of damage due to plugged culverts washing out and loss of road surface and fill

B. Beneficial Uses of Water: Water Quality/Aquatic Habitat

- Floatable debris (ash, burned wood) and increased fine sediment from accelerated hillslope erosion delivered to streams can cause elevated nutrients, suspended sediment, turbidity, and accumulation of fines in pool habitat
- Accelerated surface and fill erosion on forest roads would result in delivery of fine sediment to stream channels

II. Resource Condition Assessment

A. Resource Setting

The El Portal Fire burned approximately 4,729 acres mostly within the Crane Creek watershed, a tributary to the Merced River within the Stanislaus National Forest and Yosemite National Park. Soil burn severity was mixed and consisted of *very low/unburned* (504 acres/11%), *low* (1171 acres/25%), *moderate* (2399 acres/51%), and *high* (657 acres/14%) (Table 1).

Elevations within the fire perimeter range from 2,200 feet in El Portal near the Merced River to 6,400 feet along the upper ridges near Crane Flat. Mean annual precipitation is approximately 39 inches per year and occurs as mostly rain with transient snow at higher areas. The terrain in the Crane Creek ranges from very steep canyon at the lower end of the watershed to more moderate slopes around the community of Foresta. The El Portal Fire area has a very active fire history and burned within the 1990 Arch Fire perimeter as well as other older fires and also a small portion of the 2009 Big Meadow Fire.

The El Portal Fire burned 26% of the Crane Creek-Merced River HUC 6 watershed as well as small portions of the Indian Creek-Merced River and Moss Creek-Merced River watersheds. Designated beneficial uses of water in the Merced River basin and its tributaries (source to McClure Lake) include: Municipal, domestic, and agricultural water use, hydroelectric power generation, contact and non-contact water recreation including canoeing and rafting, warm and cold freshwater habitat, and wildlife habitat (CRWQCB 2011). Streams in the fire area are mostly ephemeral (77 miles), followed by perennial (7miles) and intermittent (5 miles).

Table 1. HUC 6 watershed acreages and percentages by soil burn severity class

HUC 6 Watershed	HUC ID	Total Acres	Very Low/Unburned	Low	Moderate	High	Outside Fire Area
Crane Creek-Merced River	180400080306	16788	466 (2.8%)	979 (5.8%)	2263 (13%)	653 (4%)	12427 (74%)
Indian Creek-Merced River	180400080305	15536	11 (0.1%)	10 (0.1%)	15 (0.1%)	4 (0%)	15496 (99.7%)
Moss Creek-Merced River	180400080307	13356	26 (0.2%)	182 (1.4%)	121 (0.9%)	0	13027 (98%)

B. Field Investigations

Potential VARs were initially identified through burn severity mapping analysis, review of previous local post-fire monitoring reports, and discussions with Yosemite National Park (YNP) staff. Field visits were then made to the identified sites; additional VARs were identified during field visits. The following VAR sites were the focus of field investigations (Figure 1):

Houses in old El Portal

House in drainage near water tank- There is a house located directly within the mouth of a 33 acre ephemeral drainage (Figures 1 and 2). The drainage is narrow, steep (average slope-63%), and very rocky with rock outcrops at its head. The entire watershed was burned, with soil burn severity dominated by *Moderate* (Table 2). This house previously experienced flooding and fine sediment deposition during a storm event in March 1991that occurred after the watershed was burned during the August 1990 Arch Rock Fire (DeGraff 1991). A rock gabion dam debris basin with an approximately 200 cubic yard capacity was constructed in the channel upstream from the house near the upper water tank after the Arch Rock Fire to provide protection from debris flows; the March 1991 event filled the structure about half full with fine sediment and ash (DeGraff 1991).

The current homeowner (who resided at the house during the 1991 storm event) was contacted and provided information. Sometime after the March 1991 storm the homeowner created a hardened flood channel and small retaining wall/levee out of rock and concrete to direct runoff away from the house. The homeowner stated that runoff occurs (under unburned conditions) only in wet years after prolonged rainfall and last occurred four years ago. According to the homeowner, under unburned conditions, runoff typically is does not cause flooding and sediment deposition; the house was originally built in 1927. The drainage becomes indistinct past the house and runoff flows around a large water tank and through another yard where it reaches the street; no other homes appear to be at risk.

House in drainage on Buckeye Road- This house is located directly within the mouth of an 18 acre ephemeral drainage and was identified during field reconnaissance (Figures 1 and 3). This drainage is also narrow, steep (average slope- 55%), and rocky with rock outcrops at its head. Nearly all the watershed (91%) was burned, mostly at a *Moderate* soil burn severity (Table 2). The drainage becomes indistinct at the house and it appears no other homes are at risk. The house experienced a small debris flow during the March 1991 storm event which deposited 1 foot of debris against the back of the house (DeGraff 1991). Several unsuccessful attempts were made to contact the homeowner. Where Foresta Road crosses the drainage upstream from the house, there is potential for runoff to divert onto the road and flow down to water tank.

Houses at base of burned hillslope- Several houses located along the base of a burned hillslope are at risk of experiencing minor nuisance runoff and sedimentation that could result from accelerated post-fire hillslope erosion.

Highway 140 bridge at Crane Creek

Staff at Yosemite National Park (YNP) expressed concern that increased post-fire peak flows could damage the bridge on Highway 140 at Crane Creek and cause temporary loss of highway access. The bridge is constructed of concrete with a natural channel bottom and has an inlet width of around 30 feet and outlet width of around 32 feet and height between 13 and 15 feet from the low flow water surface elevation. It was estimated that at bankfull peak flow (approximate recurrence interval of 1.5 years) there is about 8 feet of freeboard remaining at the inlet. Bankfull width 150 feet upstream of the bridge was estimated at 26 feet. This information indicates the bridge has adequate hydraulic capacity to pass expected high flows.

Foresta Road

Staff at YNP expressed concern that access on Foresta Road, between Foresta and El Portal, could be lost due to post-fire storm damage. There are three bridges on Foresta Road within the fire perimeter, two on Crane Creek and

one on Little Crane Creek. One bridge on Crane Creek had the railing burn but is otherwise passable; the other bridge had the wood decking burn and is impassable. Both bridges on Crane Creek do not appear to be at risk of post-fire storm damage due to the low proportion of burned area in the upstream watershed. The bridge on Little Crane Creek was not visited but appeared from a distance to be similar to the lower bridge on Crane Creek and is probably adequately sized and constructed to handle high flows. There is an intermittent stream crossing between Little Crane and Crane Creek but it was not visited and the type (e.g., culvert, bridge) and condition of the crossing is unknown. Numerous other ephemeral stream crossings were noted on Foresta Road, most of which do not have any culverts or other structures and will be vulnerable to erosion and road loss by increased post-fire flows.

Table 2: Analysis watershed acres by soil burn severity class and percentage

Watershed	Total Acres	Very Low/ Unburned	Low	Moderate	High	Outside Fire Area
El Portal Fire Area	***4728***	***504 (11%)***	***1171 (25%)***	***2399 (51%)***	***657 (14%)***	-
Water Tank Drainage	33	1 (4%)	2 (5%)	25 (76%)	5 (14%)	0
Buckeye Road Drainage	18	1 (4%)	4 (20%)	10 (55%)	2 (11%)	2 (9%)
Crane Creek at Hwy 140	11296	462 (4%)	945 (8%)	2202 (19%)	649 (6%)	7038 (62%)
Little Crane Creek at Foresta Rd Bridge	3245	434 (13%)	777 (24%)	1354 (42%)	437 (13%)	243 (7%)
Crane Ck Tributary at Foresta Road	128	0	1 (1%)	94 (73%)	34 (26%)	0

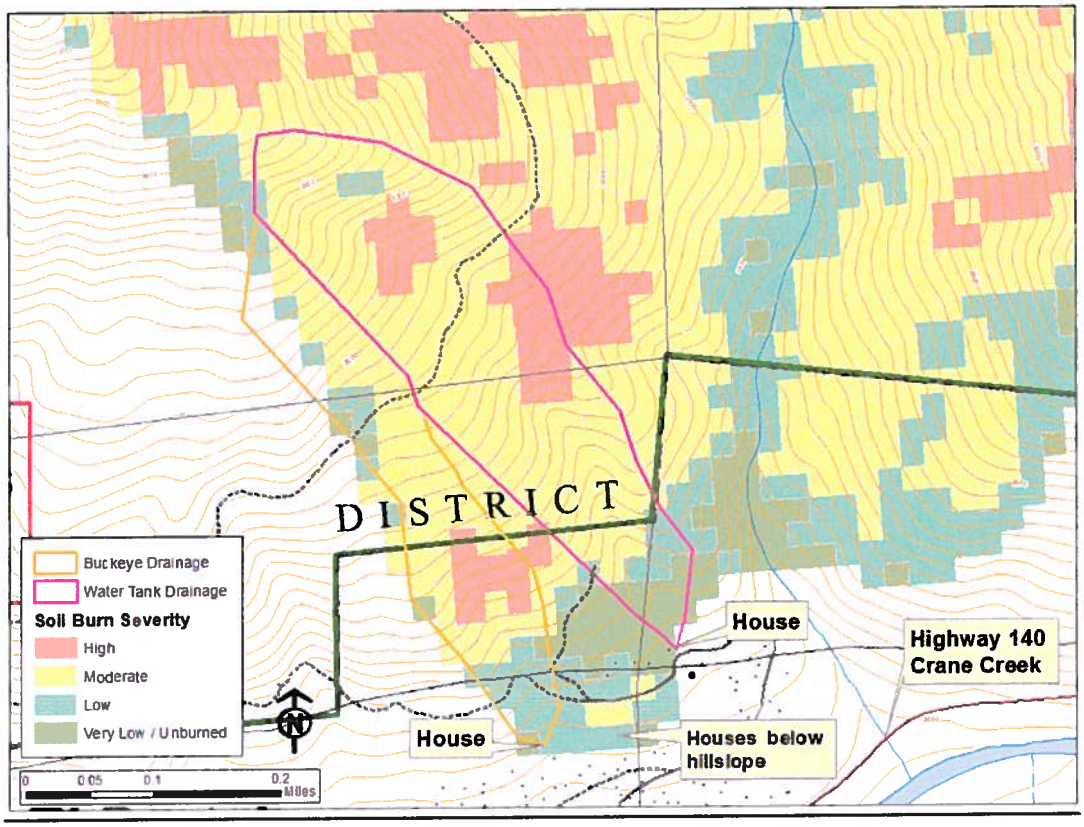

Figure 1: Map of fire area showing the houses in drainages and Crane Creek bridge at Highway 140

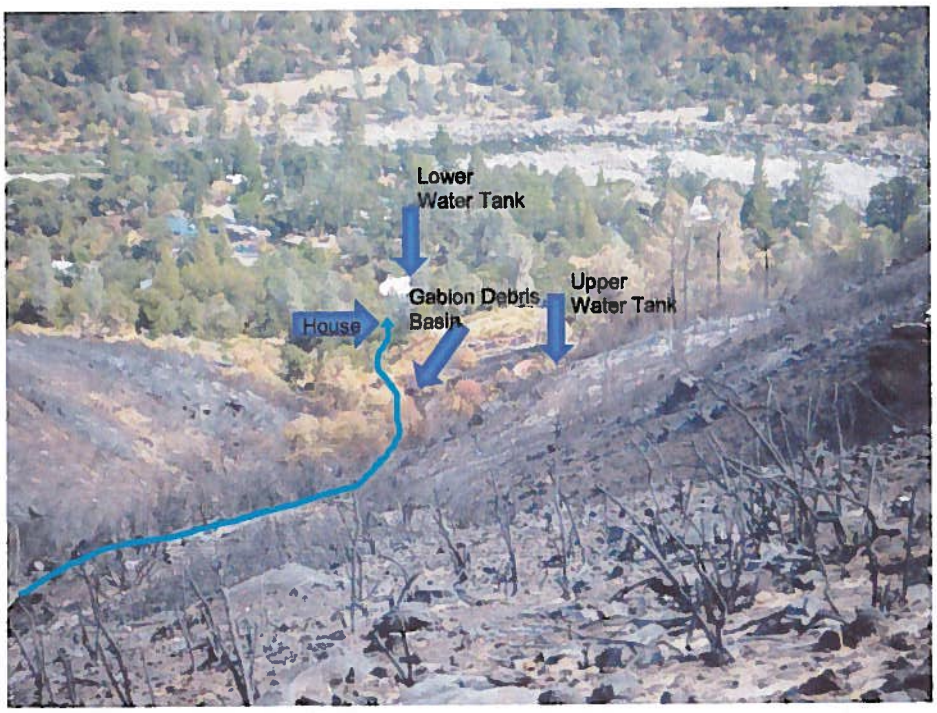

Figure 2: Looking down into water tank drainage from Foresta Road

Figure 3: Looking down into Buckeye Road drainage from Foresta Road

C. Hydrologic Modeling

Stream peak flows are expected to increase during the coming winter due to reductions in soil ground cover and infiltration and decreased evapotranspiration from loss of vegetation. Peak flows will be bulked by ash, burned wood and other floatable debris, and sediment eroded from hillslopes and channels. Under these post-fire conditions, debris-laden floods could pose threats to critical values.

In order to estimate the magnitude of potential increases in stream peak flows, hydrologic modeling was conducted on the five pour-point watersheds within the fire area containing potential VARs (Figure 1). Flows were modeled for the two small drainages with houses in them in old El Portal (Water Tank Drainage, Buckeye Road Drainage), Crane Creek Bridge at Highway 140, Little Crane Creek Bridge on Foresta Road, and an intermittent tributary to Crane Creek with an unknown type of stream crossing on Foresta Road (Table 2). A detailed description of the modeling methodology used can be found in Appendix A.

A 2-year recurrence interval peak flow was used as a conservative estimate of a peak flow magnitude that could be potentially damaging to VARs and has a high likelihood of occurrence within the next 1 - 4 years, when the watersheds are most susceptible to elevated peak flows and erosion. A 2-year peak flow event has a 50% probability of occurrence in any given year and a 94% probability of occurring at least once over the next 4 consecutive years. Modeling pre- and post fire peak flow involves a high degree of uncertainty; modeled flows should be considered estimates of the relative expected change in post-fire hydrologic response which are used to help identify VARs and prioritize treatment.

Table 2: Modeled pre- and post-fire peak flows for pour-point watersheds

Watershed	Watershed Acres	% of Watershed Burned	Pre-Fire Peak flow (cfs)	Post-Fire Peak flow (cfs)	Peak flow Increase (percent)	Peak flow Increase (times)
Water Tank Drainage	33	100	2	6	230	3.3
Buckeye Road Drainage	18	91	1	3	181	2.8
Crane Creek at Hwy 140	11296	38	265	423	60	1.6
Little Crane Creek at Foresta Rd Bridge	3245	93	85	216	155	2.5
Crane Ck Tributary at Foresta Road	128	100	5	17	275	3.8

Table 3 presents results of modeled year-1 maximum erosion rates within the analysis watersheds and equivalent sediment volumes delivered to each watershed pour point for a 2-year recurrence interval storm, similar to the magnitude of storm expected to generate the modeled post-fire peak flows (see the *BAER Soil Resources Report* for details of modeled erosion rates and sediment production).

Table 3: Modeled pre- and post-fire erosion and sediment production for 2-year storm event

Watershed	Pre-Fire Erosion			Year 1 Post-Fire Erosion: 2-yr storm		
	Erosion Rate (tons/ac)	Total Sediment (tons)	Total Sediment (cu yds)	Erosion Rate (tons/ac)	Total Sediment (tons)	Total Sediment (cu yds)
Water Tank Drainage	0.4	12	9	8.8	290	203
Buckeye Road Drainage	0.3	6	4	7.8	127	89
Crane Creek at Hwy 140	0.6	2718	1903	8.6	36770	25739
Little Crane Creek at Foresta Rd Bridge	0.7	1966	1376	8.3	24849	17394
Crane Ck Tributary at Foresta Road	0.1	15	10	8.5	1089	763

Results and Discussion

Modeled post-fire peak flow increases for the 2-year flow range from 60% for Crane Creek at Highway 140 to 275% for the Crane Creek tributary. Post-fire 2-year flows for the water tank drainage (6 cfs) and the Buckeye Road drainage (3 cfs) may not appear very impressive at first but considering that the houses are located squarely in the drainages and the volume of sediment predicted to be delivered by a 2-year event (203 cu yds to water tank, 89 cu yds to Buckeye), both houses are at high risk due to flooding, mud and possibly debris flows (for visualization purposes, 6 cfs can fill a 20,000 gallon swimming pool in 7.5 minutes). Past history of flooding and debris flows at the homes during the March 1991 storm after the Arch Rock fire provides probably the best indicator of post-fire risk. The storm event that caused the March 1991 mud and debris flows is estimated to have been a 2-year/4-day recurrence interval event, one that has a good likelihood of occurrence in any given year. Similarly, small debris flows in the nearby 2011 Motor Fire area were triggered by 2 inches of rain over a 14 hour period (DeGraff et al. 2012). That rain event has an approximate recurrence interval of 1-year/12 hour.

Post-fire 2-year flows on Crane Creek at Highway 140 are estimated to increase to 423 cfs, a relatively modest increase that the bridge should be able to easily pass without damage. The stream crossing on the intermittent Crane Creek tributary may be at risk of failure due to increased flows and debris; however, the hydraulic capacity of the crossing is unknown and it is, therefore, not possible to make that determination presently.

III. Emergency Determination

A. Threats to Critical VARs

Based on field investigations, modeling of expected post-fire peak flows, and past history of post-fire impacts, there is a high risk to critical values (human life and property) to the two houses in the drainages in El Portal and to people travelling on Foresta Road between Foresta and El Portal, and, therefore, an emergency exists. Foresta Road is at high risk of rock fall and road washouts. Several other houses in old El Portal at the base of a burned hillslope were identified as being at risk of only minor nuisance sedimentation that could result from erosion on the hillslope. Modeling and field evaluation indicate that the Highway 140 bridge at Crane Creek is at low risk of impacts due to the modest increase in estimated post-fire flows and the adequate hydraulic capacity of the bridge.

Based on field investigations and modeling of expected post-fire peak flows and sediment yield, there is a low risk to water quality and aquatic habitat and, therefore, an emergency does not exist. The magnitude of peak flow increases and sediment yield estimated by the models does not appear likely to pose a significant risk to water quality and aquatic habitat. The Merced River is a large stream that has adequate flow and transport capacity to dilute and move downstream increased debris and fine sediment loads transmitted from the fire area. Reach-scale water quality and aquatic habitat in the Merced River could be affected by increased nutrients, suspended sediment and debris, increased turbidity, and increased fine sediment in pools; however, these effects are expected to be minor and short-term in duration and occur during storms or snow melt in the first 1 - 2 years after the fire.

IV. Treatments to Mitigate Risk to Critical Values (Figure 4)

A. House in drainage near water tank on Foresta Road

- The existing gabion dam debris basin adjacent to the upper water tank should be initially cleaned out and then subsequently monitored and cleaned out after storms as needed.
- Sand bags or other type of barrier should be used to raise the height of the existing retaining wall/ levee to better protect the house from flooding and debris. This structure would be designed in consultation with a geotechnical engineer.

B. House in drainage on Buckeye Road

- A debris basin and/or deflection barrier should be installed at the mouth of the drainage behind the house on Buckeye Road. The structure should be designed to slow the momentum of a debris or mud flow before it reaches the house, have the capacity to provide some storage of fine sediment/larger

debris, and redirect flows around the house. The structure could consist of a gabion dam, k-rails, or some other type of temporary or permanent structure. The structure should be designed in consultation with a geotechnical engineer.

- The burned hillslopes in the drainage adjacent to the house should be mulched with weed free straw or wood straw to provide soil ground cover in order to reduce sheet and rill erosion. Straw should be applied at a rate of around 2 tons per acre.

C. Road drainage improvement on Foresta Road in Old El Portal

- Where Foresta Road crosses the drainage flowing down to the house on Buckeye Road, there is potential for flows to divert onto Foresta Road and continue all the way to the lower water tank. The paved section of Foresta Road from the upper water tank access road down to the lower water tank should have sections of the outside berm removed to allow runoff to disperse onto the hillslope in the event of stream diversion. Rock dissipators and straw bales should be installed where runoff leaves the road at berm breaches to dissipate runoff on the hillslope. In addition, a rock armored dip should be installed where the drainage crosses the road to reduce the potential for stream diversion.

D. Hillslope mulching

- The burned hillslope behind the houses on Foresta Road in old El Portal should be mulched with weed free straw or wood straw to provide soil ground cover in order to reduce sheet and rill erosion. Straw should be applied at a rate of around 2 tons per acre.

E. Installation of precipitation stations for NOAA warning system

- Two precipitation stations should be installed in the Crane Creek watershed for NOAA to be able to provide early warnings of impending storms with high potential for flooding, mud and debris flows. Residents of homes at risk can be alerted in advance when evacuation may be advisable.

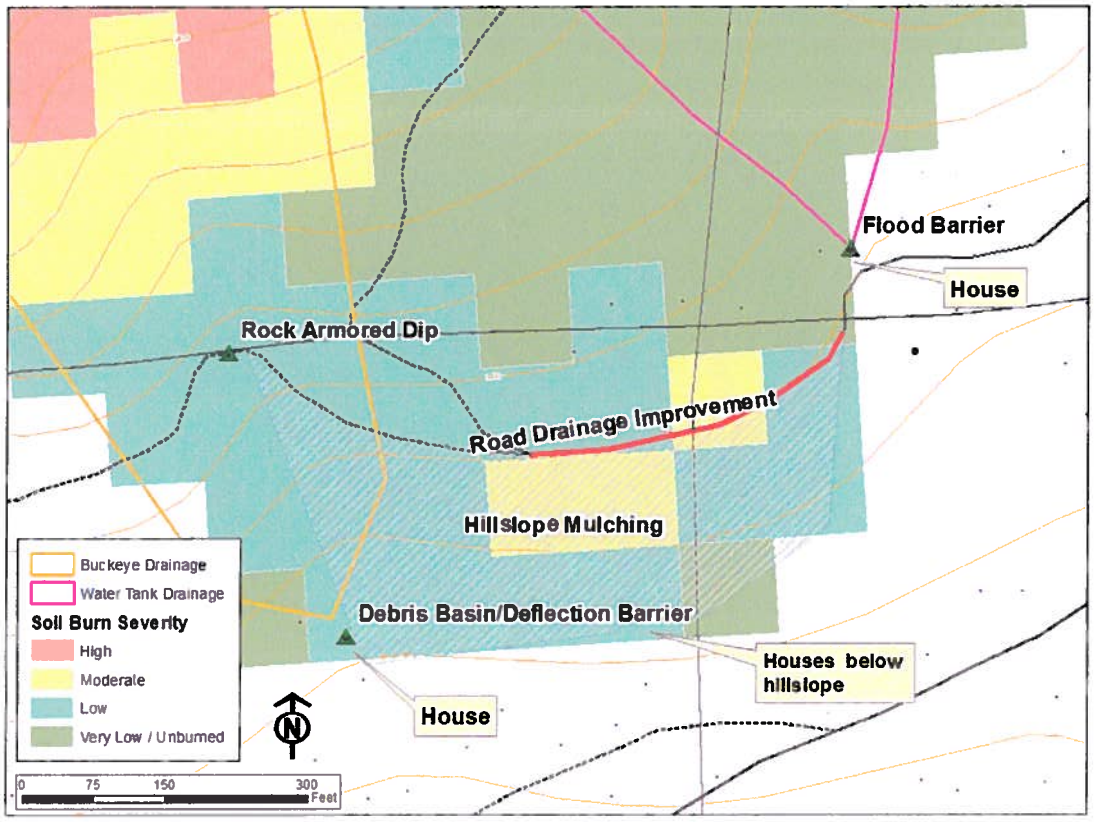

Figure 4: Location and types of proposed treatments

El Portal Fire BAER Assessment - Hydrology Specialist Report
Stanislaus National Forest and Yosemite National Park
August 2014

Appendix A: Pre- and Post-Fire Peak Flow Modeling Methodology

Pre-Fire Peak Flows

Regional flood frequency equations for the Sierra Nevada hydrologic region were used to obtain estimates of pre-fire peak flows for the analysis watersheds, as described in Gotvald et al. (2012). The 2-year recurrence interval (RI) peak flow (50% annual exceedance probability) was used as a conservative estimate of a pre-fire peak flow magnitude that could be potentially damaging and has a reasonable likelihood of occurrence within the next 1 - 4 years, when the watersheds are most susceptible to elevated peak flows and erosion. The following equation was used to obtain the 2-year RI pre-fire peak flow estimate:

2-year RI $$2.43(DRNAREA)^{0.924}(ELEV)^{-0.646}(PRECIP)^{2.06}$$

where *DRNAREA* is the watershed drainage area (mi^2), *ELEV* is the mean basin elevation (ft), and *PRECIP* is mean annual precipitation (inches) (Gotvald et al. 2012). Drainage area for pour-point watersheds was obtained using GIS; mean basin elevation and mean annual precipitation were obtained using StreamStats (USGS 2013). Table 1 gives model parameters used for pre-fire peak flows and results.

Table 1: Pre-fire peak flow model inputs and results

Watershed	DRNAREA (mi2)	ELEV (ft)	PRECIP (in)	Pre-fire 2 year RI Peak (cfs)	Pre-fire 2 year RI Peak (cfs/mi2)	Post-fire 2 year RI Peak (cfs)	Post-fire 2 year RI Peak (cfs/mi2)
Water Tank Drainage	0.05	2843	38.1	2	32	6	107
Buckeye Road Drainage	0.03	2704	38.1	1	35	3	98
Crane Creek at Hwy 140	17.6	5307	39.6	265	15	423	24
Little Crane Creek at Foresta Rd Bridge	5.1	5152	39.5	85	17	216	43
Crane Ck Tributary at Foresta Road	0.2	4313	38.5	5	23	17	85

Post-Fire Peak Flows

Post-fire peak flows were estimated by adjusting pre-fire peak flows based on the proportion of soil burn severity classes (*Low, Moderate, High, Very Low/Unburned*) within each pour-point watershed, which are obtained from the Burned Area Reflectance Classification (BARC) soil burn severity map. To estimate changes in post-fire peak flows, the following assumptions were made: areas of *Low* soil burn severity would have a peak flow response that is a 30% increase in the 2-year RI peak flow; *Moderate* severity would respond as a 5-year RI (20% annual exceedance probability) peak flow; *High* severity would respond as a 10-year RI (10% annual exceedance probability) peak flow; *Very Low/Unburned* would respond as a 2-year RI (50% annual exceedance probability) peak flow. The proportion of burn severity classes within each watershed was obtained using GIS; these proportions within different burn severity classes were then multiplied by the 2-year, 5-year, and 10-year RI peak flows and summed to obtain the post-fire peak flow estimate for each watershed. The 2-year RI peak flow was calculated as explained in the pre-fire peak flow section. The 5-year and 10-year peak flows were calculated using the following equations, also from Gotvald et al. (2012), using the same input parameters given in Table 1:

5-year RI $$11.6(DRNAREA)^{0.907}(ELEV)^{-0.566}(PRECIP)^{1.70}$$

10-year RI $$17.2(DRNAREA)^{0.896}(ELEV)^{-0.486}(PRECIP)^{1.54}$$

The post-fire modeled flows were then multiplied by a bulking factor of 1.25 that accounts for sediment entrained in the flows and represents a maximum sediment concentration of 20% for a water flow (Elliot et al. 2005).

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2014 El Portal Fire
Geologic Hazard Assessment Report
Stanislaus National Forest

Resource Specialty: Geology
Fire Name: El Portal Fire
Month and Year: August, 2014
Author(s) Name and Home unit Name: Alan J. Gallegos, Sierra National Forest

Report

I. Potential Values at Risk (identified prior to the on-the-ground survey)
Two houses located in El Portal at 5674 Foresta Road and 9722 Buckeye Road are located within moderate debris flow hazard areas. Forest Road (FR 2S84) is at risk from both debris flows and rock fall hazards.

II. Resource Condition Assessment

A. Resource Setting – The El Portal Fire is located in Little Crane Creek between Moss Creek and Crane Creek. The southern end of the fire is located on steep canyon slopes of the Merced River. The steep canyon slopes are dominated by mass wasting processes including rock slides, rock falls and debris flows. Several debris basins are located within the fire area. Moderate and high soil burn severity occurs in these steep canyon slopes. The geology of the fire area includes igneous intrusive and metamorphic rocks. These rocks include the Granite of El Capitan, Bass Lake Tonalite, Pilot Ridge Quartzite, and Pilot Ridge Quartzite and Schist (see Figure 1). The Arch Fire occurred in 1990 and the Motor Fire occurred in 2011. Debris flows occurred in the following winter after these two fires. Damage occurred to several houses in El Portal after the Arch Rock Fire in 1991 (see DeGraff, 1991) and several houses had flood damage and California State Highway 140 had debris flow damage during the winter after the 2011 Motor Fire (DeGraff and Others, 2012).

B. Findings of the On-The-Ground Survey
1. Resource condition resulting from the fire: The fire resulted in high and moderate burn severity on some of the steepest slopes in the fire area. These steep slopes have several houses in the community of El Portal that are threatened by debris flows (see Photos 1 and 2). The Foresta Road (FR 2S84) is located within a watershed with steep slopes and several channel crossings. The channel crossings have the potential to pass debris flows and there are several sections along the road with high and moderate rock fall hazard (see Photos 3 and 4).

2. Consequences of the fire on values at risk
    a. Risk Assessment – The United States Geologic Survey conducted a debris flow assessment of the fire area that shows debris flow hazard classes and probability

of debris flows occurring for multiple precipitation events including the 2 year, 5 year, 10 year, 25 year and 50 year storm events. The 10 year event was used to evaluate debris flow potential for the fire area (see Figure 2). The two houses are located downstream from Moderate Debris Flow Hazard Areas with a 20-40% probability of 1000 – 10,000 yds^3 debris flows to move down the channel. One of those houses is constructed within the flood plain of the channel with very little cross-sectional area for water to pass much less a debris flow. It is highly likely that if a debris flow flows down this channel that it will destroy the corner of the house and could potentially take the life of someone occupying the room near the channel.

A risk assessment for the two houses and the Foresta Road (FR 2S84) was conducted resulting in a very high risk (see Table 1).

Table 1 – Risk Assessment of Values at Risk

Value-at-Risk	Probability of Damage or Loss	Magnitude of Consequences	Risk
House #1	Very Likely	Major	Very High
House #2	Likely	Major	Very High
Foresta Road FR 2S84	Very Likely	Major	Very High

III. Emergency Determination – An emergency exists at the two houses in El Portal. There is a threat to life and property from debris flows that have a Moderate Debris Flow Hazard, 20-40% probability of occurring, with a potential for debris flow volumes from 1000 – 10,000 yds^3. House # 1 is located at 5674 Foresta Road and House #2 is located at 9722 Buckeye Road. An emergency exists for the Foresta Road (FR 2S84). There is a section of Foresta Road located in a High Debris Flow Hazard watershed, 60-80% probability of debris flows occurring, with a potential for debris flow volumes from 10,000 – 100,000 yds^3. The Foresta Road crosses 11 channels, all with a Moderate Debris Flow Hazard.

IV. Treatments to Mitigate the Emergency

Foresta Road (FR 2S84)

1. Treatment Type (including monitoring if applicable): Close Forest Road 2S84. Close the two existing gates and 2 road closure signs and install rock fall and debris flow warning signs when road is opened.
2. Treatment Objective: to limit exposure of people to the hazards along the Foresta Road.
3. Treatment Description: Implement hard road closure with two existing gates on both ends of the fire and rock fall and debris flow warning signs when the road is reopened.
4. Treatment Cost: $2,000
5. Probability of Completing Treatment Prior to Damaging Storm or Event:
   Land (slope) __ % Channel ___ % Roads_**100**_% Trails___%

Two Houses in El Portal

1. Treatment Type (including monitoring if applicable): Warn and Notify Residents of Hazard In two houses in El Portal. Warning should consist of a letter of warning to the owners of the two houses. The letters should describe the debris flow potential and what could happen to their house and anybody in the house if a debris flow occurs. An Early Alert Warning System consisting of a warning from the National Weather Service (NWS) of pending storms, the National Park Service (NPS) and the residents in the two houses.
2. Treatment Objective: Notification of the potential of debris flows to occur and potential storms that could result in debris flows that could damage the houses and pose a threat to life in the houses.
3. Treatment Description: Letter to home owners mailed to address of record and personal delivery of copy of letter to home. Rain gages or stream discharge gages.
4. Treatment Cost: 1 day salary to compose letter by GS-11 - $350.00. Early warning system consisting of two rain gages and one stream gage. The estimated cost of this equipment is approximately $24,000. There will be an additional cost to maintain equipment which could be at least $10,000.
5. Probability of Completing Treatment Prior to Damaging Storm or Event:

Land (slope) __ % Channel __ % Roads_75_% Trails___%

6. Probability of Treatment Success

	Years after Treatment		
	1	3	5
Land			
Channel			
Roads/Trails			
Protection/Safety	75%	50%	25%

7. Cost of No-Action (Including Loss):

Potential loss of life at one or both of the houses in the community of El Portal and along the Foresta Road if it is not closed.

8. Cost of Selected Alternative (Including Loss): **$37,000**

V. Discussion/Summary/Recommendations –

Debris flows and rock falls are eminent in the El Portal Fire Area. Debris flow hazard areas have been identified with the aid of USGS Debris Flow Modeling. The debris flow modeling data was used to identify values at risk that have some potential of threats from debris flows. Rock fall hazard areas have been identified along the Foresta Road and reviewed in the field. Treatments for debris flow and rock fall hazards include notification of the owners/residents of the two

houses in El Portal and the public of these hazards through letters, warning signs and early alert systems and road closures.

VI. References

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Appendices

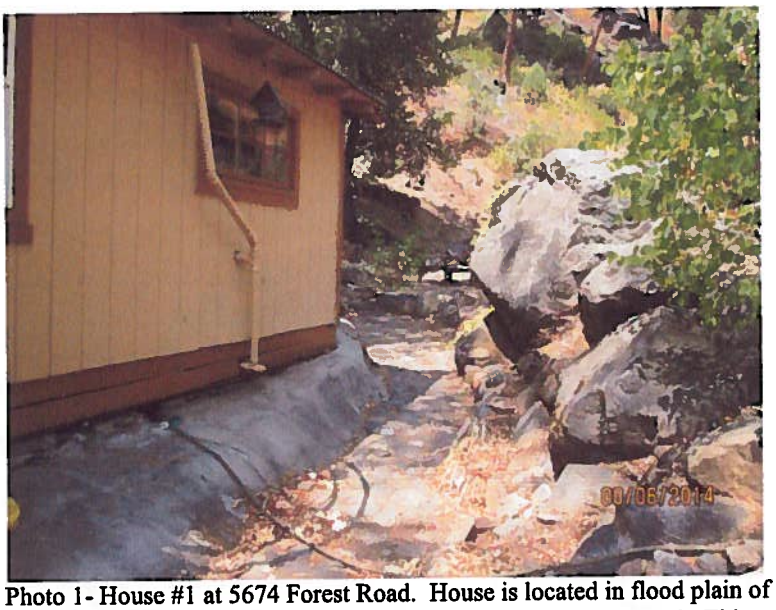


Photo 1- House #1 at 5674 Forest Road. House is located in flood plain of channel and has constricted the cross-sectional area of the channel. This house has slopes above with moderate debris flow hazard and the potential for 1000-10,000 yds^3 of debris flow material to pass through this narrow channel. There is a very high risk to life and property at this site.

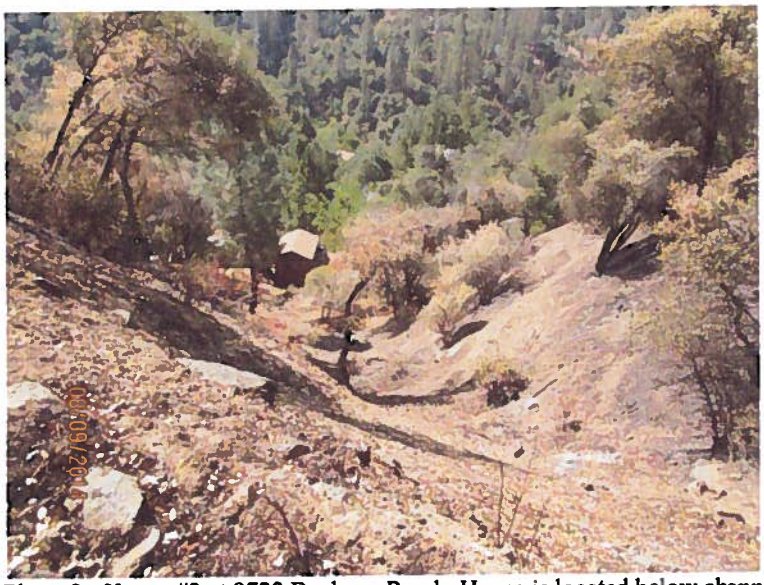


Photo 2 - House #2 at 9722 Buckeye Road. House is located below channel with slopes that have a with moderate debris flow hazard and the potential for 1000-10,000 yds3 of debris flow material to pass through this narrow channel. There is a very high risk to life and property at this site.

Photo 3 - Foresta Road (FR2S84) This road has high and moderate debris flow and rock fall hazard. People driving this road could get trapped behind rock fall and are at risk from getting hit by a rock.

Photo 4 - Foresta Road (FR2S84) This section of road has a moderate rock fall hazard. People driving this road could get trapped behind rock fall and are at risk from getting hit by a rock.

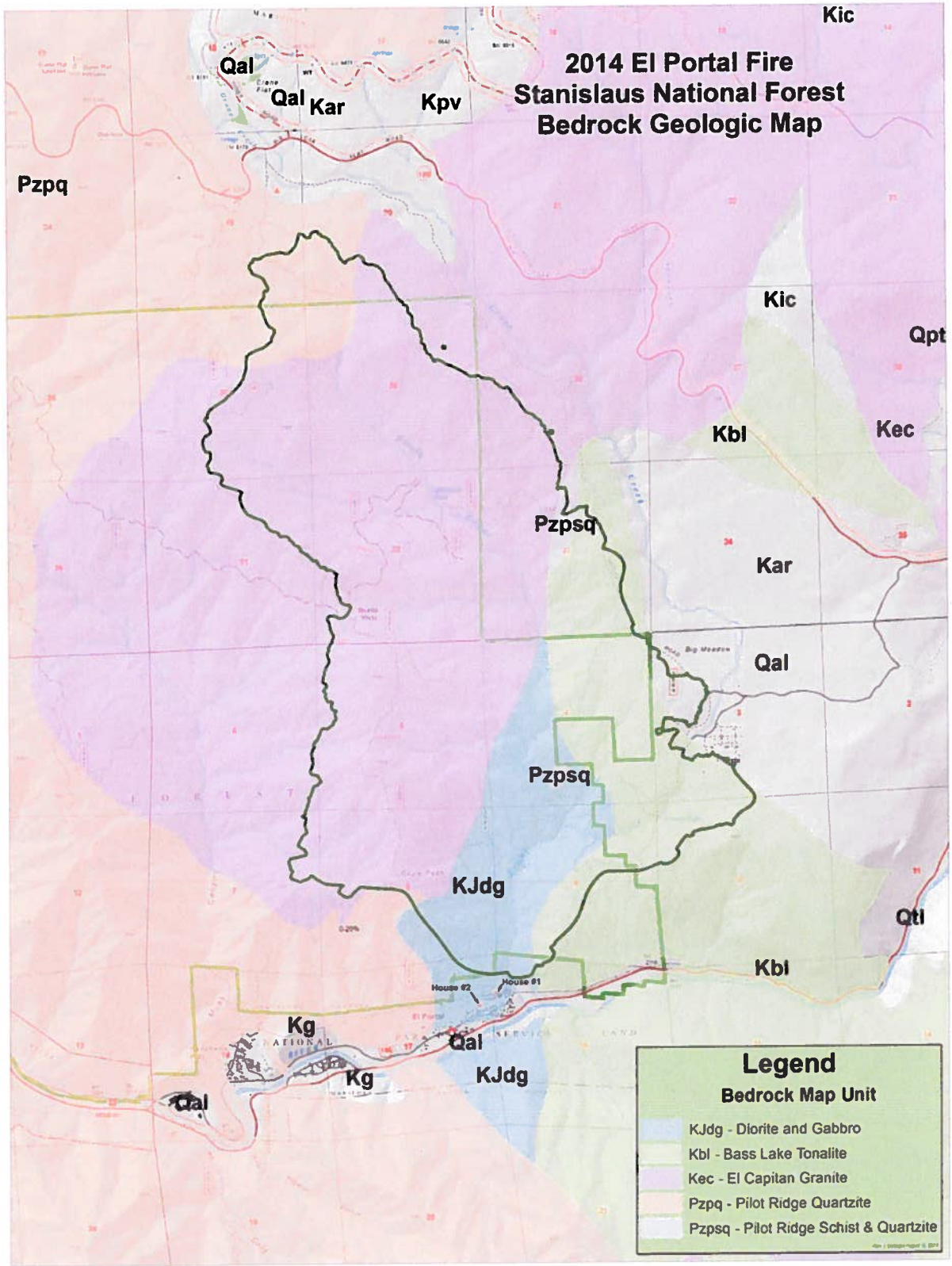


Figure 1 - Geologic Map of the El Portal Fire Area. Most of the area is underlain with igneous intrusive rocks from the El Capitan Granite and Bass Lake Tonalite.

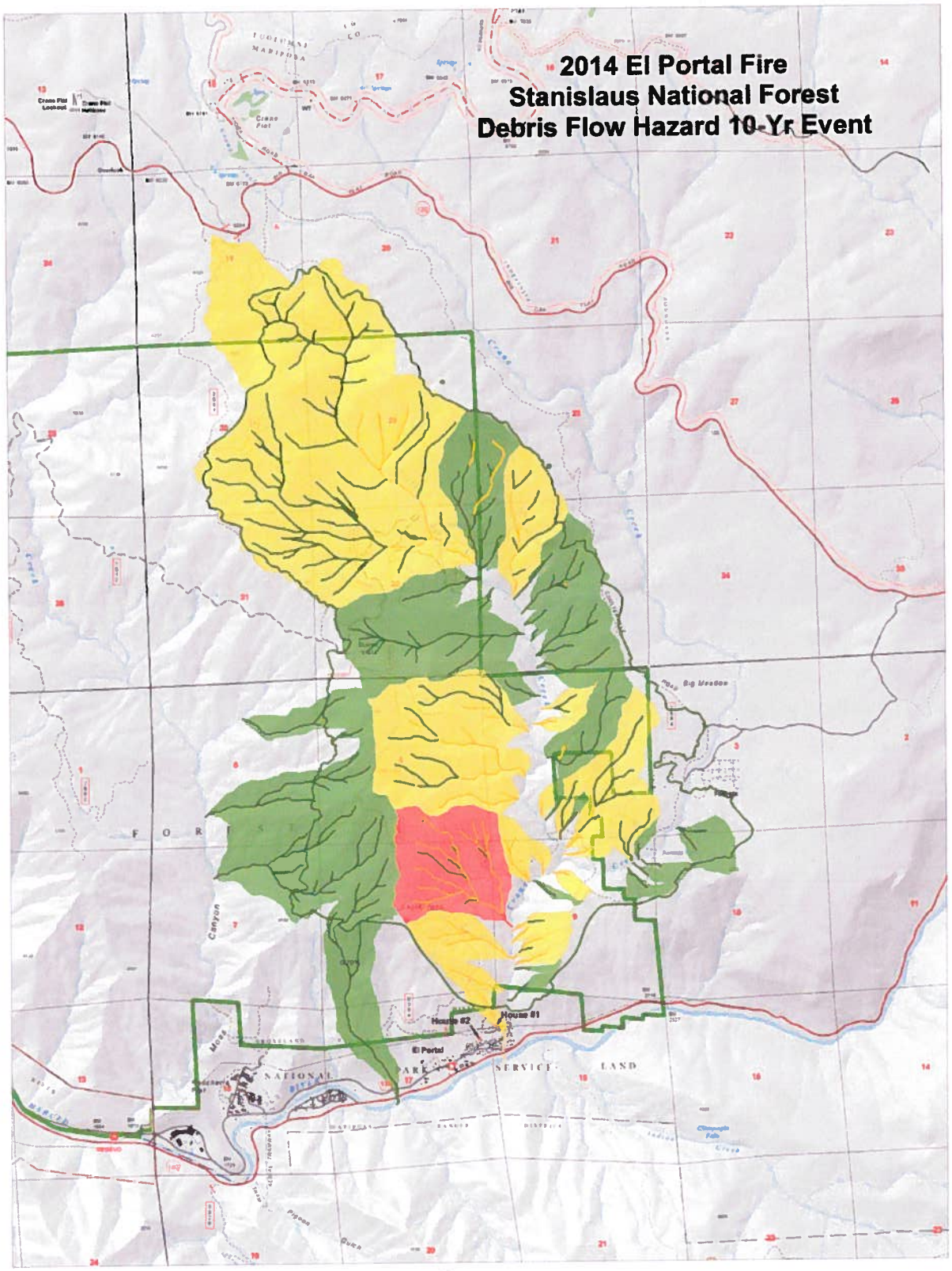
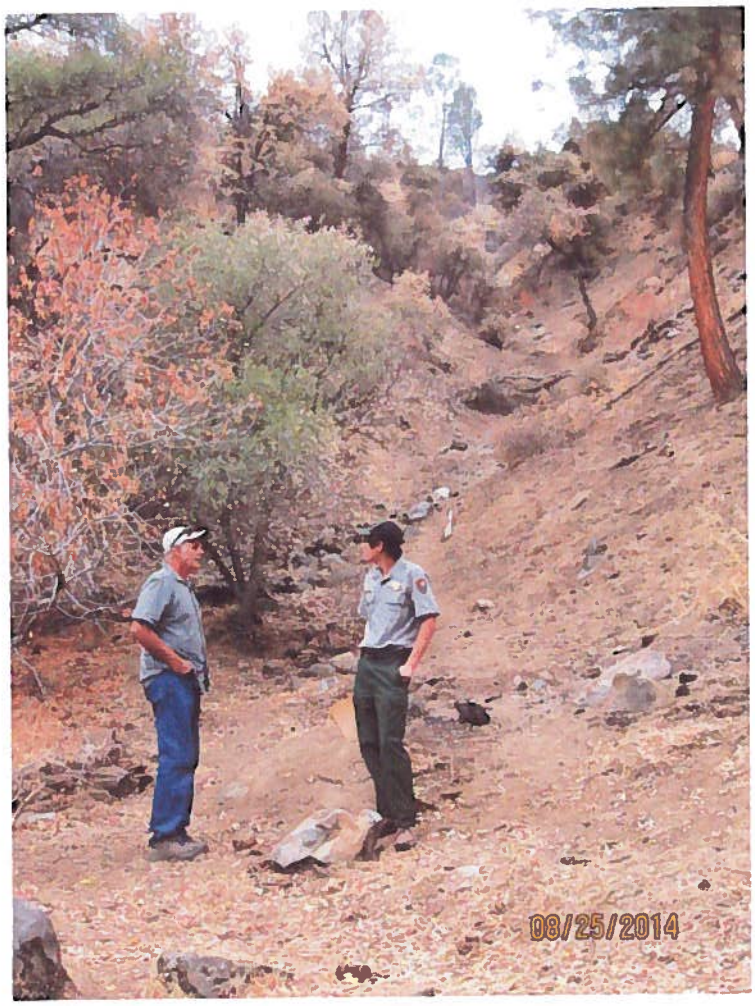


Figure 2 – Debris Flow Hazard Map showing houses #1 and #2 downslope of moderate debris flow hazard areas. Note red shaded area, where Foresta Road is located. This area is a high debris flow hazard area.



Buckeye Photo: 2193 – Area of potential gabion debris dam.

Buckeye Photo: 2195 – Area of debris deflection barrier.

CONDOR

Buckeye Photo: 2196 – Area of deflection debris

Foresta Road Photo 2208 – Owner constructed deflection barrier in progress

CONDOR

Foresta Road Photo 2211 – Existing Debris Dam, looking at downstream side.

Foresta Road Photo 2215 – Existing Debris Dam upstream side filled to near capacity.

CONDOR